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# Ivan M. Sechenov (1829–1905)

**Yury V. Gavrilov · Philipp O. Valko**

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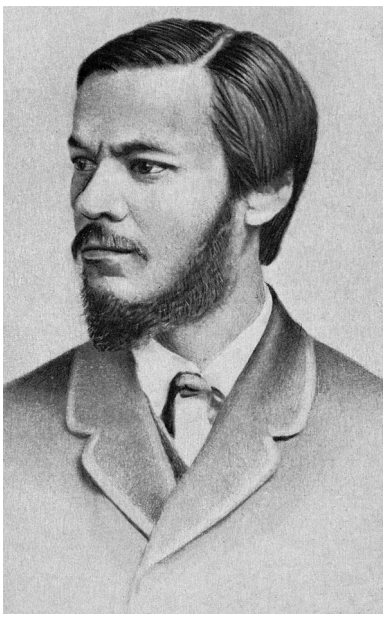
**Abstract** This article summarizes the life and work of the Russian physiologist Ivan M. Sechenov (1829–1905).

**Keywords** Sechenov · Central inhibition · Russia · Physiology



Y. V. Gavrilov (✉) · P. O. Valko
Department of Neurology, University Hospital Zurich, Zurich, Switzerland
e-mail: yury-doctor@mail.ru

P. O. Valko
e-mail: philipp.valko@usz.ch

Y. V. Gavrilov
Department of General Pathology and Pathological Physiology, Institute of Experimental Medicine, St. Petersburg, Russia

Born on August 13, 1829, in a small village near Simbirsk on the Volga, Ivan Michailovich Sechenov played a prominent role in the development of physiology in his home country—Pavlov considered him "the father of Russian physiology"—and his many contributions have had sustained impact worldwide. Together with Friedrich Goltz, Sechenov pioneered the modern study of reflexes, culminating in his classic "The reflexes of the brain" [3]. He discovered the concept of central inhibition, and raised both an intense dispute and storm of outrage by claiming that psychic life is nothing else than cerebral reflex activity and that "the initial cause of any human action lies outside the person". Many of his works dealt with higher nervous functions—summarized under telling titles such as "Elements of thought" (1878), "On objective thinking from a physiological standpoint" (1894), "Impressions and reality" (1895)—making Sechenov a forerunner of physiological psychology [5, 7, 8].

Born into a noble family, Ivan Sechenov was the youngest of 8 brothers and sisters. From 1843 to 1848, he attended the St. Petersburg Engineering School, where he received a rigorous education in physics and mathematics, allowing him years later to analyze complex physiological processes. In 1851, Sechenov went to the Medical Faculty of the Moscow University, which he finished in 1856. Using his own savings, Sechenov then visited the leading physiological laboratories of Western Europe. Between 1856 and 1859 he worked with Johannes Peter Müller (1801–1858), Emil Heinrich Du Bois-Reymond (1818–1896), Felix Hoppe-Seyler (1825–1895), Ernst Heinrich Weber (1795–1878), and Otto Funke (1828–1879). It was in Vienna, however, where he met his most influential teacher, Carl Ludwig (1816–1895), whom he considered an "incomparable tutor and friend" [1]. In Spring 1858, upon the recommendation of Ludwig,

Sechenov went to Heidelberg to Hermann von Helmholtz (1821–1894) and Robert Wilhelm Bunsen (1811–1899). Exploring the function of the visual system, Sechenov discovered the phenomenon of fluorescence of the lens.

While in Berlin, he attended lectures on physics and chemistry held by Heinrich Gustav Magnus (1802–1870) and Heinrich Rose (1795–1864). To assess the impact of alcohol on blood gases, Sechenov designed a special blood pump, which deeply impressed Ludwig and other leading physiologists. Soon, this device was used by many others. The physiology of blood gases remained a life-long interest, in particular the identification of the structure of carbon dioxide. In 1889, based on experimental evidence, Sechenov succeeded in analysing the nature of the solubility of gases, which was subsequently referred to as "Sechenov's equation".

In 1860 he defended his doctoral thesis entitled "Materials for future physiology of alcoholic intoxication" at the Medico-Surgical Academy of St. Petersburg. In the same year, he received a scientific position in the faculty of physiology and established a physiological laboratory, which was one of the first in Russia. A devoted and enthusiastic mentor, Sechenov was among the first to demonstrate experiments to his audience. For his lecture on animal electricity, he was awarded the Demidovskij prize of the St. Petersburg Academy of Science.

In 1862, political upheavals distracted his work in St. Petersburg, and Sechenov decided to join Claude Bernard's (1813–1878) laboratory in Paris, where he experimentally confirmed the hypothesis of a central control of movement. He observed that stimulation of the rostral brainstem led to an inhibition of limb reflexes in frogs. Painful irritation of the animal's legs with a dilute acid triggered a delayed withdrawal when stimulating the brain at the midbrain level [2, 4]. Furthermore, he reported similar effects on his own hand during co-activation by other sensory inputs [10]. His discovery was of major impact in the history of neurophysiology. The midbrain center of inhibition and the phenomenon of central inhibition were subsequently referred to as "Sechenov center" and "Sechenov inhibition", respectively. Horace Winchell Magoun (1907–1991), one of the pioneers in identifying the brainstem reticular formation, acknowledged "Sechenov was the first to introduce 100 years ago the concept of unspecific systems of the brain". Charles Scott Sherrington (1857–1952) affirmed in his 1932 Nobel lecture that the doctrine of inhibitory influences between distinct centers of the central nervous system had become widely accepted in the field of neurophysiology since Sechenov's seminal publication [9].

In 1870, Sechenov left the Medical-Surgical Academy as a sign of protest against the university's decision not to elect Sechenov's protégée and future Nobel laureate Ilya Mechnikov (1845–1916) as full professor. For a short period, Sechenov worked in the laboratory of the University of St. Petersburg. Thereafter, Sechenov worked from 1871 to 1876 as professor of the Novorossiskij University in Odessa. The next positions in his academic career were the St. Petersburg University (1876–1888), and finally Moscow University, where he got an appointment to the chair of Physiology.

Examining the cause of ataxia, Sechenov speculated about a "dark muscular sensation", a subconscious muscular perception. Producing pioneering works on proprioception, Sechenov believed that cortical analysis of sensory information arising from moving muscles contributes to the perception of the outer world. Starting from this concept, Sechenov regarded proprioception as the basis of any thinking process. Later on, Sechenov started a new cycle of papers addressing the problem of central inhibition. In 1882, he noted electrical potentials at the level of the medulla oblongata and the spinal cord, a remarkable observation made well ahead of Berger, Adrian and other 20th century electrophysiologists [6].

Sechenov enjoyed a high reputation amongst colleagues from various fields. He kept life-long friendships with many extraordinary Russians, including master clinician and therapist Sergey Botkin (1832–1889), composer and chemist Alexander Borodin (1833–1887), and the chemist and inventor of the Periodic table Dmitri Mendeleev (1834–1907). Mechnikov, his closest friend, described him as a strong-willed yet unusually pure and passionately honest personality [1]. A modern and liberal mind, Sechenov enthusiastically supported the struggle of Russian women to get access to higher education, and organized medical courses for women in Moscow. Among the first female students were Bokova and Suslova, who attended lectures at the Medico-Surgical Academy. Under Sechenov's supervision, both Bokova and Suslova prepared their medical theses, which they successfully completed in Zurich, Switzerland. On November 15, 1905, Sechenov died of pneumonia in the Russian capital.

**Conflicts of interest** All authors declare that they have no conflict of interest.

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